PLASTIC SCREW CLOSURE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a Continuation-in-Part of U.S. Patent Application Serial No. 09/367,443 filed August 13, 1999, which is a national phase entry of PCT Application PCT/DE98/00266 filed January 29, 1998, which claims priority to German Application No. 197 05 717.9 filed February 14, 1997.

BACKGROUND OF THE INVENTION

The present invention concerns a plastic screw closure for bottles, comprising a substantially cylindrical peripheral portion with an internal screw thread for screwing onto the external screw thread of a bottleneck, and a top plate portion which is substantially in the form of a circular disc and a substantially cylindrical sealing strip which extends axially inwardly from the inside of the top plate portion and whose outside diameter approximately corresponds to the outside diameter of the bottleneck or is slightly larger and whose inside diameter is clearly smaller than the outside edge of the bottleneck.

A plastic screw closure of that kind for bottles is already known from DE 41 28 474.

The known plastic screw closure is intended for screwing onto the screw threaded neck of bottles and is of such a design configuration that the substantially cylindrical strip bears from above and the outside onto the edge of the bottleneck and in so doing bears sealingly substantially along the upper outer rounded-off edge of the bottleneck or the mouth of the bottle. In that arrangement, the sealing strip is additionally also clamped between an outer substantially cylindrical bead or ridge and the bottleneck and is pulled and pressed into firm sealing engagement with the edge of the bottleneck. In principle, such a closure could also be used for plastic bottles, for example PET-bottles.

In the case of multi-use bottles, the bottles generally and in particular also the bottlenecks and mouth openings are visually checked before they are reused. In that respect, however, the possibility cannot be excluded, that damage to the edge of the bottleneck in the region where it

comes into sealing engagement with the closure cap or sealing elements of the closure cap is overlooked, particularly if such damage is relatively small an inconspicuous. In principle that also applies for plastic bottles, in particular for the PET-bottles which are increasingly used. When dealing with plastic bottles, under some circumstances, due to the production procedure involved it is also necessary to reckon on rather larger manufacturing tolerances or damage occurring in the course of manufacture or handling. Minor damage, in particular in the form of small dents or grooves, can only be visually detected with difficulty. It can therefore certainly happen that bottles are filled and closed, when the edge of the bottleneck thereof has suffered minor damage, deformation or unevenness and irregularities caused by the manufacturing procedure and which are easily overlooked in a checking operation but which are sufficient to have an adverse effect on the sealing engagement between the edge of the bottleneck and sealing elements of the closure cap. That applies in particular if the interior of the bottle is under pressure, for example when using the bottles for carbonated drinks. A poor seal in the case of such bottles can have the result that gas escapes from the bottle and as a result causes a drop in pressure, which in turn results in outgassing of the carbon dioxide contained in the drink, which then after a storage time of some days or weeks, has substantially lost its carbon dioxide and correspondingly tastes stale.

WO 96/02430 already discloses a closure cap which is intended to ensure particularly good sealing engagement. Instead of a substantially cylindrical sealing strip, this known closure cap however has a substantially horizontally extending sealing strip which bears against the upper edge of the bottleneck, while in addition annular projections are provided at the bottom or the top plate portion of the closure cap and are intended to come into engagement with the sealing strip on the side thereof in opposite relationship to the edge of the bottleneck, and apply a linear sealing pressure to the sealing strip. The arrangement additionally also has an inner substantially cylindrical sealing olive, in which respect the term “olive” clearly defines the lower cross-section of that part which has an outwardly projecting region which is also intended to come into substantially linear engagement with the cylindrical inside surface of the bottleneck. Admittedly, the inside surface of a bottleneck is generally fairly precisely defined, at least in the case of PET-bottles, but it may certainly involve damage, so that the projection of the sealing olive cannot guarantee reliable sealing integrity, in spite of the substantially linear engagement of

the sealing olive with the interior of the bottleneck. In addition, the sealing projection of the known closure is disposed at a considerable spacing relative to the point of attachment of the sealing plate portion to the top plate portion so that the arrangement does not afford very high elastic return or contact pressure forces in the region of the projection.

A substantially radially extending sealing plate admittedly partially covers over the outer, generally well-defined, rounded-off edge of the bottleneck which however can also be damaged, but just like the sealing olive it does not involve the inner, slightly rounded-off edge configuration of the edge portion of the bottleneck. These parts which are positioned in different ways relative to the axis of the closure define a blind hole-like depression with a considerable undercut configuration which gives rise to major problems in manufacture and in the operation of pressing out air, which is required in that context.

WO 96/26121 discloses a corresponding screw closure which, besides a substantially conically outwardly directed, peripherally extending sealing plate which is intended to come into engagement with the outer edge of the bottleneck, additionally also has an inner centering projection whose outside diameter however is somewhat smaller than the inside diameter of the bottleneck. That projection therefore does not come into sealing engagement with the interior of the bottleneck and in particular not with the upper inner edge of the bottleneck.

Because of the conical shape of the sealing plate, removal of such a closure from an injection molding tool is a relatively difficult and complicated procedure. That applies even more in regard to the above-mentioned closure disclosed in WO 96/02430 in which the sealing plate extends parallel to the top plate portion radially inwardly virtually in one plane and, together with a further inwardly disposed sealing olive, defines a virtually closed hollow space or cavity.

The known closures therefore have at least in part problems in terms of manufacture and in particular removal from a mould and on the other hand they still do not guarantee absolutely sound sealing integrity in the event of minor damage or deformation of the edge of the bottleneck.

SUMMARY OF THE INVENTION

In comparison with that state of the art, the object of the present invention is to provide a plastic screw closure having the features set forth in the opening part of this specification, which still better prevents leaks in the event of slight damage or deformation of the edge of the bottleneck and which in addition if possible should be easily removable from a mould in order to facilitate manufacture with an injection molding tool which is of the simplest possible structural configuration.

That object is attained in that the plastic screw closure, in addition to the features set forth in the opening part of this specification, includes the further features that provided radially within the cylindrical sealing strip is a further, substantially cylindrical sealing olive whose outside diameter at least in the region near the top plate portion and opposite to the sealing strip is larger than the inside diameter of a bottleneck for which the closure is intended.

While the outer sealing strip which is approximately of the configuration as in the case of known DE 41 28 474 thus provides for really good sealing integrity in respect of the upper outer edge of the bottleneck, there is additionally provided an inner sealing olive which additionally also seals off the inside surface at the upper edge of the bottleneck. The latter effect is achieved in that, in the region which is near the top plate portion and opposite to the sealing strip, that is to say in the region in which, when the closure is screwed onto a bottle, the upper edges of the bottleneck normally also lie, the sealing olive is still of a larger outside diameter than the inside diameter of the bottleneck or the edge of the bottleneck in that region, so that therefore the inner sealing olive is urged away radially inwardly and, when that happens, it bears sealingly against the inside surface of the edge of the bottleneck. The diameter conditions in regard to the sealing strip and the sealing olive necessarily mean that, in a given axial position and in particular in the axial region in which the upper edge of the bottleneck is disposed, the internal spacing between the sealing strip and the sealing olive must be smaller than corresponds to the thickness of the edge of the bottleneck. In that respect, a particularly preferred embodiment of the invention is one in which the internal spacing between the sealing strip and the sealing olive in the sealing region is less than two thirds and under some circumstances even less than half the thickness of

the bottleneck. Since both the sealing olive and the sealing strip preferably comprise the plastic material of the closure, they enjoy sufficient elasticity to be urged away by the edge of the bottleneck when the closure is fitted onto the bottle and is screwed fast, while however coming into very firm sealing engagement with the upper edge of the bottleneck, by virtue of the elastic return forces which occur in that case.

In addition, the preferred embodiment of the invention provides that, on its outside, the sealing olive has a shallow bead or ridge which in cross-section is approximately in the shape of an obtuse triangle.

In that respect, it is to be borne in mind that the fact that the inner projection is urged radially inwardly is equivalent to compression of the material which constitutes the sealing olive. The bead which is of a correspondingly larger outside diameter on the one hand comes into sealing engagement with the inside surface of the edge of the bottleneck and in so doing causes greater compression of the material constituting the sealing olive and thus an increase in the elastic return force which ultimately ensures reliable and secure sealing engagement.

At its free end the sealing olive is preferably rounded-off and/or beveled so that, in the event of axial movement in the direction of the bottleneck, the sealing olive is also actually urged radially inwardly and does not rest on the edge of the bottleneck or is not urged radially outwardly.

In a similar fashion, in the preferred embodiment the sealing strip, at its free end, is also of a rounded-off and/or beveled shape so that upon axial movement in a direction towards the bottleneck it is spread radially outwardly when it comes into engagement with the edge of the bottleneck.

Overall the preferred alternative configurations of the sealing strip and the sealing olive can be characterized to the effect that deviations thereof from a precise hollow-cylindrical shape are essentially limited to the outside wall of the projection and the inside wall of the sealing strip. In that respect, in the preferred embodiment, the olive is approximately twice as thick and at least

50% longer (in the axial direction) than the sealing strip. Preferably, the axial length of the sealing olive is even about twice the axial length of the sealing strip. By virtue of that relatively massive configuration of the sealing olive, in the preferred embodiment of the invention, the deviation of the outside diameter of the sealing olive from the diameter of the edge of the bottleneck, at any event in the region where the sealing action essentially occurs, is less than the corresponding deviation of the inside diameter of the sealing strip from the outside diameter of the edge of the bottleneck as the sealing strip is thinner and shorter and can thus be more easily elastically stretched and moved away.

Preferably the outside surfaces of the sealing olive and the inside surface of the sealing strip extend substantially parallel over the axial extent of the sealing strip, that is to say, over the length of the sealing strip, there is a substantially constant internal width between the sealing olive and the sealing strip, and the outside surface of the sealing olive extends, particularly at the axial height of the end of the sealing strip, parallel to the beveled and round-off shape thereof. In cross-section therefore the hollow space or cavity which is formed between the sealing olive and the sealing strip is of a narrow configuration having a tapering shape and a rounded top, is open at its lower end and closed at the top. In that arrangement, in terms of cross-section, the hollow space or cavity, which extends in a slightly curved configuration from bottom to top, is of a substantially constant width and decreases in width only at its upper closed and rounded-off end, while the upper portion, with respect to the axis of the closure, is almost cylindrical and the lower portion enlarges outwardly in a conical configuration. The axial length of the hollow space or cavity which is markedly narrower than the thickness of the associated bottleneck is defined by the length of the outer sealing strip which is in turn relatively short so that, in the condition of being screwed onto a bottleneck, it thus just completely embraces the outer, rounded-off edge of the bottleneck. That means that the narrow hollow space or cavity between the sealing olive and the sealing strip remains axially correspondingly short which facilitates the manufacturing operation and also makes the configuration of a suitable injection molding tool simpler. In specific terms, this hollow space or cavity is of an axial depth (corresponding to the axial length of the sealing strip) of less than 4 mm, preferably less than 3 mm and in particular about 2.5 to 3 mm.

With the somewhat tapering cross-section configuration of the upper portion of the hollow space between the sealing strip and sealing olive, one effect is that the upper surface of the bottleneck is not in a flush resting engagement with the top plate surface due to the fact that the hollow space extends into the top plate. As such, the top plate portion immediately above the hollow space is slightly thinner than in the remainder of the top plate. This results in the effect that the sealing strip may be slightly better extended even close to the top plate area where the thinner portion of the top plate acts like a king of "hinge," substantially minimizing stress cracking of the extended sealing strip.

The free end of the peripheral portion of the screw closure is preferably integrally provided with a guarantee or anti-tamper and tear-off band. As also generally, the closure in the preferred embodiment is produced in one piece from a homogenous plastic material using injection molding. The substantially cylindrical shapes of the sealing olive and the sealing strip and the short axial length thereof permit relatively easy and simple removal of the molded article from the mould and also allow the manufacturing tool to be of a correspondingly simple shape.

BRIEF DESCRIPTION OF THE DRAWINGS

Further advantages, features and possible uses of the present invention will be clearly apparent from the following description of a preferred embodiment and the accompanying drawings in which:

Figure 1a shows an embodiment of a screw closure according to the invention in a sectional view containing the axis, on an enlarged scale;

Figure 1b shows a side view of the screw closure of Figure 1a, approximately in original size;

Figure 1c shows a fragmented sectional view containing the axis, on an enlarged scale of the screw closure of Figure 1a taken along section line 1c –1c;

Figure 2 shows the closure of Figure 1 in the same axial sectional plane but in a condition of being screwed onto a bottleneck;

Figure 3 shows another embodiment of a screw closure according to the invention in a section view containing the axis, on an enlarged scale;

Figure 4 shows the closure of Figure 3 in the same axial sectional plane but in a condition of being screwed onto a bottleneck; and

Figure 5 is a section view of a conventional threaded bottle neck having a thread with a substantially horizontally extending terminal end portion.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

Figure 1a shows the screw closure according to the invention, in a longitudinal section containing the axis thereof. The screw closure substantially comprises a cylindrical peripheral portion 1 with a top plate portion 2 which is integrally joined thereto and which is approximately in the shape of a circular disc. An anti-tamper and tear-off band 7 is also attached to the free end of the cylindrical peripheral portion, also in one piece with the peripheral portion 1. The anti-tamper and tear-off band 7, by unscrewing of the screw cap, is torn open by a bottle or tears off the peripheral portion 1 and thus identifies that the bottle has already been opened.

The cylindrical peripheral portion 1 has in internal screw thread 8 which is interrupted in portions thereof, while on its outside it has gripping knurling 9 which is intended to make it easier to apply torque when gripping the closure cap with the fingers.

The two elements which afford sealing integrity with the bottleneck, are the cylindrical sealing strip 4 which extends in an annular configuration around the closure and the sealing olive 3 which also extends in an annular configuration and parallel to the sealing strip 4. As can be seen, the outside wall of the cylindrical sealing strip 4 and the inside wall of the cylindrical sealing olive 3 extend straight in the cross-sectional view and are thus fairly precisely cylindrical. The inside wall of the cylindrical sealing strip 4 having an inside diameter $2r_2$, which is clearly smaller than an outside diameter D of bottleneck 10 (Figure 2), extends parallel to the axis of the closure, only over a relatively short portion, and is then rounded-off in the direction of the free end 21 and extends inclinedly outwardly. The outside wall of the cylindrical olive 3 has a bead or ridge 6 which is shallow in cross-section, approximately in the form of an obtuse-angled triangle, wherein the obtuse angle of the obtuse-angle triangle defines the maximum outside diameter of the bead or projection 3 and axially approximately coincides with the free end 21 of the sealing strip 4. Then, towards the top plate portion 2, the outside wall of

the cylindrical sealing olive 3, starting from the bead or ridge, extends approximately parallel to the end portion which extends in an inclined and rounded-off configuration, before it again extends approximately parallel to the axis and then follows an arcuate path to blend into the inside wall of the sealing strip 4.

The mutually facing surfaces of the sealing strip 4 and the sealing olive 3 extend parallel over the greatest part of the axial length of the sealing strip 4.

The axial length of the sealing olive 3 is greater than the axial length of the sealing strip 4 by at least 50% and preferably by about 100%.

The deviations of the hollow-cylindrical shape of the sealing olive 3 and the sealing strip 4 are substantially limited to the outside wall 12 of the sealing olive and the inside wall 13 of the sealing strip 4.

In cross section therefore the hollow space or cavity 14 which is formed between the sealing olive 3 and the sealing strip 4 is of a narrow configuration which is slightly concavely curved and rounded-off at the top, and the hollow space or cavity is open at its lower end and closed at the top. The internal spacing ($r_2 - R_1$) between the sealing strip 4 and the sealing olive 3 in the sealing region is less than two thirds and optionally less than half the thickness $|D - d|$ (Figure 2) of the bottleneck 10. In that arrangement, in terms of cross-section, the hollow space or cavity 14 which extends in a slightly curved configuration from bottom to top, is of a substantially constant width and decreases in width only at its upper closed and rounded-off end, while the upper portion, with respect to the axis of the closure, is almost cylindrical and the lower portion enlarges outwardly in a conical configuration. The axial length of the hollow space or cavity which is markedly narrower than the thickness of the associated bottleneck is defined by the length of the outer sealing strip 4 which is in turn relatively short so that in the condition of being screwed onto a bottleneck, it thus just completely embraces the outer, rounded-off edge 15 (Figure 2) of the bottleneck. That means that the narrow hollow space or cavity 14 between the sealing olive 3 and the sealing strip 4 remains axially correspondingly short, which facilitates the manufacturing operation and also makes the configuration of a

suitable injection molding tool simpler. In specific terms, this hollow space or cavity 14 is of an axial depth (corresponding to the axial length of the sealing strip) of less than 4 mm, preferably less than 3 mm, and in particular about 2 to 2.5 mm.

Figure 1b shows a side view of the closure in approximately natural size. The drawing clearly shows the knurling 9 on the outside of the screw cap, which is intended to make it easier to screw the closure on and off, as well as the lower anti-tamper and tear-off band 7. In other respects, the closure is shown in Figures 1 and 2 precisely true to scale, the dimension R_a being somewhat less than 31 mm. Because the view is shown to scale, that dimension can be used as a basis for exactly deriving all other dimensions, and the absolute and relative dimensions of all elements are disclosed in the Figures, by virtue of the views being true to scale. It will be appreciated however that the invention is not limited to observing the absolute and relative dimensions of the individual elements of the closure cap.

The free end of the sealing olive 3 is also clearly rounded-off so that, when the free end of the olive 3 meets a bottleneck, the free end of the sealing olive 3 will slide away and be urged inwardly. Figure 2 shows the plastic screw closure once again in the same sectional plane, but in the condition of the internal screw thread 8 being screwed fast onto an external screw thread 11 a bottleneck 10. It will be seen that the sealing olive 3 is urged inwardly by virtue of its rounded-off free end coming into engagement with the end face of the bottleneck 10, while the bead 6 bears against the inner cylindrical surface 16 of the bottleneck. It will be seen that in this case the cylindrical olive 3 is displaced inwardly and compressed so that a corresponding elastic return force is produced, which provides for firm sealing engagement.

At the upper outer edge 13 of the bottleneck, sealing integrity is afforded by virtue of engagement with the sealing strip 4 which, when its free rounded-off or beveled end comes into engagement with the end face of the bottleneck, is displaced outwardly and is then clamped between the outside surface 18 of the bottleneck and a cylindrical bead 5 and is draw by the bead 5 around the upper outer edge 13 of the bottleneck. The bead 5, as shown in Figure 1a, is provided at the transition between the top plate portion and the peripheral portion of the closure cap and has a substantially cylindrical inside surface having a diameter of $2R_i$, which is at most

equal to and preferably somewhat smaller than the sum of diameter D of the bottleneck and double the thickness of the sealing strip 4. It is to be appreciated that this diameter $2R_i$ is independent of the inner diameter of screw thread 8, wherein the inner diameter of the screw thread may not be smaller than the outer diameter of the bottle neck adjacent the thread.

In regard to the details of the good sealing engagement achieved thereby, attention is directed to DE 41 28 474. As the sealing olive 3 is markedly thicker and preferably approximately twice as thick (without having regard to the bead) as the sealing strip 4, the preferred embodiment of the invention provides that the outside diameter $2R_1$ of the sealing olive in the region in which it comes into engagement with the upper edge 17 of the bottleneck involves a smaller difference in relation to the inside diameter d of the edge of the bottleneck in that region than the sealing strip 4 with its inside surface relative to the outside edge of the neck of the bottle as , with the same force acting, the sealing strip 4 is more easily deformable than the sealing olive 3. This can also be clearly seen from Figure 2 and by the comparison with Figure 1. The difference in diameter $|d - 2R_1|$ between the sealing olive and the inner edge of the bottleneck, when the closure is not screwed onto a bottleneck, is only about a third to a quarter of the difference in diameter $D - 2r_2$ between the inside surface of the sealing strip and the outer edge of the neck of the bottle.

As such, the deviation $|2R_1 - d|$ of the outside diameter $2R_1$ of the sealing olive 3 from the inside diameter d of the bottleneck is markedly less than the deviation $|2r_2 - D|$ of the inside diameter $2r_2$ of the sealing strip 4 from the outside diameter D of the bottleneck. In one embodiment, the ratio of the deviations is at least 1:2, preferably 1:3 to 1:5, and in another embodiment, the ratio of the deviation is about 1:2 to about 1:3.

Since both, the sealing olive and the sealing strip preferably comprise the plastic material of the closure, they enjoy sufficient elasticity to be urged away by the edge of the bottleneck when the closure is fitted onto the bottle and is screwed fast, while however coming into very firm sealing engagement with the upper edge of the bottleneck, by virtue of the elastic return forces which occur in that case.

The closure according to the invention provides that both the upper outer edge and also the inside surface of the mouth of the bottleneck is gripped and sealed between two mutually oppositely disposed sealing elements. The arrangement thus affords two virtually equivalent seals which are independent of each other so that, in the event of damage, deformation or deviation in tolerances of the upper edge of the bottleneck having remained untouched, there is still a relatively great probability that at least one of the two seals ensures adequate sealing integrity, as it is improbable that the damage or deformation which involves both the upper outer edge and also the upper inside surfaces of the edge of the bottleneck remains unnoticed.

In addition, the bottleneck 10 applies to the two sealing elements, radially opposed forces which substantially neutralize each other. That ensures that the top plate portion (or end portion of the closure cap) which carries those forces in the case of conventional seals which are in contact at one side does not yield to those forces due to a slow flow or creep phenomenon, so that the sealing engagement does not become gradually weaker.

Furthermore, the top plate portion 2 has a somewhat reduced thickness *t* along a small annular portion of the inside surface of the screw cap between the sealing olive 3 and sealing strip 4, and is best shown by Figure 1c. The reduced thickness *t* provides the top plate portion 2 with a slightly larger resiliency in this weakened annular portion 23. The weakened annular portion 23 permits the screw closure, even though providing a very tight sealing action between the sealing olive 3 and the sealing strip 4, to be opened rather easily since the weakened annular portion 23 somewhat reduces the forces by which the screw closure is held against the bottleneck 10.

In another embodiment show by Figures 3 and 4, the screw closure is essential the same as the previous embodiment discussed above with regard to Figures 1a, 1b, and 2. Accordingly, for the sake of brevity only the differences in this further embodiment will be discussed. In the embodiment shown by Figures 3 and 4, the bead 5 transitions substantially horizontal at a lower end portion 5a thereof to the cylindrical peripheral portion 1, rather than in an inclined transition as shown in Figures 1a and 2. It is to be appreciated that the typical thread for PET-bottles is somewhat flattened along the substantially horizontally extending terminal end 26 of the

uppermost thread 11a (Figure 5). This results in the fact that, upon tightly screwing the screw closure onto the bottleneck 10, the lower end portion 5a of the bead 5 will finally seat on or engage the terminal end 26 of the uppermost thread 11a. The advantage of this arrangement is that any axial pressure exerted on the top of the closed bottle, such as it may occur when a number of packages of such bottles are stacked for transport or storage, is well absorbed and transferred via the bead 5 onto the uppermost thread 11a, leaving the sealing members 3 and 4 substantially unaffected.

What is claimed is: